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DANGER OF INFECTION WITH TUBERCULOSIS BY
DIFFERENT KINDS OF EXPOSURE.

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The experiments with which this article deals were made at the experiment station of the Bureau of Animal Industry in order to determine the comparative danger of infection with tuberculosis through different forms of exposure. For this purpose a number of guinea pigs and hogs were exposed to tubercular cattle in a manner somewhat resembling the exposure encountered by man and animals under what may be called existing, natural or normal conditions.

The guinea pigs used were divided into four lots, which, for convenience, are designated as lots A, B, C, and D. They were raised at the experiment station, and, as no case of tuberculosis has occurred among the guinea pigs at the station for a period of ten years which was not induced by an intentional or conscious inoculation or exposure, no doubt can arise as to the source of the infection through which a number of the guinea pigs in the experiments became tubercular.

Guinea pigs lot A received intraabdominal injections of milk from tubercular cows.

Guinea pigs lot B were fed the milk of tubercular cows. During the time of milk feeding, these were entirely deprived of water in order to force them to consume the maximum quantity of milk. As a rule, guinea pigs soon acquire a taste for milk, and frequently learn to like it so much that the moment the vessel containing it is placed before them they drink copiously.

Guinea pigs lot C were confined in cages fastened to the walls of box stalls occupied by tubercular cattle, at a right angle to the walls against which the mangers were located. The average size of the box stalls, in which the cows were permitted to move about unfastened, was 8 by 10 feet. The walls of the stalls were solid, 2 inches thick and 6 feet high, and the several stalls used were sufficiently separated to prevent the passage of infectious material from one to the other. The guinea-

pig cages were 2 feet wide and 1 foot deep, and had solid wooden floors and backs and open sides, fronts and tops covered with large-meshed wire. The distance from the floors of the cages to the floors of the stalls was $4\frac{1}{2}$ feet, which was sufficient to prevent the cattle from throwing material directly into the cages; that is, above the horizontal line in which cattle extend their heads and necks when coughing. This form of exposure is referred to in the following records as room exposure. Its resemblance to the occupancy of rooms in common by healthy and tubercular-diseased individuals is apparent without further comment.

Guinea pigs lot D were confined in cages constructed under the mangers in stalls occupied by tubercular cattle. The arrangement was such that a small amount of feed sifted from the mangers to the cages while the cattle were eating. This form of exposure is referred to as manger exposure.

The hogs used in the experiments were simply fed milk from tubercular cows. They were kept in field pens $4\frac{1}{2}$ by 12 feet in area, from 100 to 150 yards from the cow stables.

The records of the cows and of the guinea pigs and the hogs exposed to them follow:

Cow No. 1 was killed July 21, 1902. She had been affected with tuberculosis several years, and at the time of her death she was so thin and weak and suffering so severely with respiratory difficulties that it would have been cruel to prolong her life. The autopsy showed an advanced generalized tuberculosis of the thoracic and abdominal organs. One of the postpharyngeal glands was enormously enlarged and converted into a cyst which, on section, was found to contain a partly softened, tubercular, necrotic material. The total amount of disease was so great that it was difficult to understand its compatibility with the persistence of life. The udder and glands associated with it were unaffected.

Guinea pigs Nos. 1 to 4, inclusive, were fed milk of cow No. 1 from August 24, 1901, to December 27, 1901—a period of one hundred and twenty-five days. The average amount of milk consumed by each guinea pig daily was 75 c. c.

Guinea pigs Nos. 5 to 8, inclusive, were fed milk of cow No. 1 from December 27, 1901, to April 23, 1902—a period of one hundred and seventeen days. The average amount of milk consumed by each guinea pig daily was 100 c. c.

Guinea pigs Nos. 1 to 8, inclusive, were killed several months after the last day on which they were fed milk, and on postmortem examination were found to be in excellent condition and free from lesions of disease.

Guinea pigs Nos. 9 to 13, inclusive, were given room exposure to

cow No. 1, beginning August 28, 1901. They died or were killed as follows:

No. 9, died November 12, 1901, seventy-sixth day; pneumonia and inflammation of the bowels.

No. 10, died November 20, 1901; eighty-fourth day; pneumonia and inflammation of the bowels.

No. 11, died December 4, 1901, ninety-eighth day; pneumonia and inflammation of the bowels.

No. 12, died July 9, 1902, three hundred and fifteenth day; pneumonia and inflammation of the bowels.

No. 13 was exposed until July 21, 1902, three hundred and twenty-seven days, and killed on September 12, 1902; on postmortem examination was found to be in excellent condition and free from lesions of disease.

Guinea pigs Nos. 14 to 21, inclusive, were given manger exposure to cow No. 1, as follows:

No. 14, exposed August 28, 1901, died January 31, 1902, one hundred and fifty-sixth day; cause of death, pneumonia and inflammation of the bowels. No tuberculosis.

No. 15, exposed August 28, 1901, died February 3, 1902, one hundred and fifty-ninth day; cause of death, pneumonia.

No. 16, exposed August 28, 1901, died March 5, 1902, one hundred and eighty-ninth day; cause of death, pneumonia and inflammation of the bowels.

Nos. 17 and 18, exposed August 28, 1901, to July 21, 1902, three hundred and twenty-seven days.

No. 19, exposed from January 21, 1902, to July 21, 1902, one hundred and eighty-one days.

No. 20, exposed from February 12, 1902, to July 21, 1902, one hundred and fifty-nine days.

No. 21, exposed from March 5, 1902, to July 21, 1902, one hundred and thirty-eight days.

Guinea pigs Nos. 17 to 20, inclusive, were killed September 12, 1902; on postmortem examination were found to be in excellent condition and free from lesions of disease. Guinea pig No. 21, which was killed on the same day as the others, was affected with tuberculosis of the liver, spleen, and mesenteric glands.

Hog. No. 1, weight about 60 pounds, was fed 500 c. c. of milk daily from cow No. 1 for a period of eighty-eight days, beginning August 27, 1901. When the hog was killed, some time later, it was found to be in excellent condition and free from lesions of disease.

As the record of a calf produced by cow No. 1 may be of considerable interest, it is here included.

The calf was born on September 28, 1901, and was in good general condition. It was allowed to remain with its mother in the stall in which it was born. On December 2 and 3, 1901, it was tested with tuberculin and a typical reaction of the presence of tuberculosis obtained. On January 8, 1902, at the age of 102 days, it was killed, and a very careful postmortem examination failed to discover a single lesion of disease.

The reaction to tuberculin indicates that the calf was affected with tuberculosis, in a stage too early to be detected by physical examination. Had the calf been allowed to live a few months longer it is quite likely that abundant lesions would have been found. The absence of observable lesions on the one hundred and second day of life certainly indicates that the affection implied by the tuberculin test was contracted after birth, from the mother, but not intrauterus.

Cow No. 2 is alive at the present time. She has been affected with tuberculosis several years and shows all the common symptoms of generalized disease—emaciation, weakness, cough, etc. No determinable lesions of the udder or glands associated with it are present.

Guinea pigs Nos. 22 to 25, inclusive, were fed the milk of cow No. 2 from August 24, 1901, to December 27, 1901—a period of one hundred and twenty-five days. The average amount of milk consumed by each guinea pig daily was 75 c. c.

Guinea pigs Nos. 26, 27, and 28 were fed the milk of cow No. 2 from December 27, 1901, to April 24, 1902—a period of one hundred and eighteen days. The average amount of milk consumed by each guinea pig daily was 75 c. c.

Guinea pigs Nos. 22 to 28, inclusive, were killed several months after the last day on which they were fed milk, and on postmortem examination were found to be in excellent condition and free from lesions of disease.

Guinea pigs Nos. 29 to 32, inclusive, were given room exposure to cow No. 2 from December 27, 1901, to September 17, 1902—a period of two hundred and sixty-four days. They were killed several months after the termination of the exposure, and on postmortem examination were found to be in excellent condition and free from lesions of disease.

Guinea pigs Nos. 33 to 36, inclusive, were given manger exposure to cow No. 2, beginning October 27, 1901, and died or were killed as follows:

No. 33 died June 13, 1902, two hundred and twenty-ninth day; cause of death, pneumonia.

No. 34 died July 22, 1902, two hundred and sixty-eighth day; cause of death, pneumonia.

Nos. 35 and 36, exposure continued until September 12, 1902, three hundred and twenty days. The last two guinea pigs were killed some time after the termination of the exposure, and on postmortem examination were found to be in excellent condition and free from lesions of disease.

In addition to the guinea pigs intentionally given manger exposure to cow No. 2, 11 guinea pigs, Nos. 37 to 47, inclusive, born in the exposure pen, were exposed, depending on the time of their birth, from sixty to two hundred days. Of these, No. 37 died when it was half grown, affected with generalized tuberculosis; and Nos. 38 and

39 died similarly affected after they had attained full adult size. Nos. 40 and 41 died when about half grown, affected with pneumonia; and Nos. 42 to 47, inclusive—3 half grown and 3 adult guinea pigs—were killed some time after the termination of the exposure, and on postmortem examination were found to be in excellent condition and free from lesions of disease.

Hogs Nos. 2 and 3, weight about 75 pounds, were fed daily from 300 to 500 c. c. of milk each from June 1, 1901, to October 4, 1901—a period of one hundred and twenty-five days. They were killed on November 15, 1901, and on postmortem examination were found to be in good condition and free from lesions of disease.

Cow No. 3 was received at the experiment station on August 9, 1900, at which time she was affected with advanced tuberculosis. On January 29, 1901, she was so thin and weak that it was a cause for surprise that she continued to live and secrete milk. She died May 17, 1901, and on autopsy was found to be affected with very extensive generalized tuberculosis of the thoracic and abdominal organs. No disease of the udder and the lymph glands associated with it was found.

Guinea pigs Nos. 48 to 55, inclusive, received each an intraabdominal injection of 6 c. c. of milk from cow No. 3 on February 12, 1901. The total number of guinea pigs injected was 8, 2 with milk from each quarter of the udder. The guinea pigs were killed about three months after the injections were made, and on postmortem examination were found to be in excellent condition and free from lesions of disease.

Guinea pigs Nos. 56 to 59, inclusive, were fed milk of cow No. 3 from January 29, 1901, to February 20, 1901—a period of twenty-two days. The amount of milk consumed by each guinea pig daily was about 50 c. c. Guinea pigs Nos. 60 to 63, inclusive, were fed milk of cow No. 3 from February 22, 1901, to May 12, 1901—a period of seventy-nine days. The amount of milk consumed daily by each guinea pig was about 50 c. c. Guinea pigs Nos. 56 to 63, inclusive, were killed some time after the last day on which they were fed milk, and on postmortem examination were found to be in excellent condition and free from lesions of disease.

From February 26, 1901, to May 17, 1901—a period of eighty days—4 guinea pigs, Nos. 64 to 67, inclusive, were given room exposure to cow No. 3, and 4 guinea pigs, Nos. 68 to 71, inclusive, manger exposure to the same cow. Guinea pig No. 68, among the manger-exposed animals, died June 23, 1901, little more than a month after the termination of the exposure, and on postmortem examination was found to be affected with generalized tuberculosis. Guinea pigs Nos. 64 to 67, inclusive, and 69 to 71, inclusive, were killed some time later, and on postmortem examination were found to be in excellent condition and free from lesions of disease.

Hogs Nos. 4, 5, and 6 were fed milk of cow No. 3 from August 9, 1900, to January 28, 1901—a period of one hundred and seventy-two days. The amount of milk consumed by each hog daily was from 500 to 700 c. c. The hogs, which at the beginning of the feeding were young animals of an average weight of 40 pounds, were killed on April 22, 1901. They had greatly increased in size and weight, and on postmortem examination were found to be in excellent condition and free from lesions of disease, with the exception of No. 4. One of the superficial inguinal glands of hog No. 4 contained a few small necrotic foci; no other lesions were found. Careful microscopic examination failed to detect tubercle bacilli in the necrotic foci, and 2 guinea pigs inoculated with small fragments of the necrotic material were killed nine months later and found on post-mortem examination to be in excellent condition and free from lesions of disease.

Cow No. 4 was affected with tuberculosis, but was fat, sleek, and in excellent general condition. The presence of tuberculosis without a tuberculin reaction would not have been suspected. She was killed on November 13, 1901, and on autopsy the only lesions found were enlarged tubercular mediastinal glands and one small recent focus of tuberculosis, 6 mm. diameter, embedded in the lung tissue under the pleura near the middle of the right principal lobe.

Beginning December 4, 1900, one guinea pig daily was injected with 6 c. c. of the milk of cow No. 4, until a total of 33 guinea pigs, Nos. 72 to 104, inclusive, had each received one injection. The guinea pigs were killed about three months after the injections were made, and on postmortem examination were found to be in good condition and free from lesions of disease.

Beginning December 4, 1900, 1 guinea pig daily was fed the milk from cow No. 4, until a total of 46 guinea pigs, Nos. 105 to 150, inclusive, had each been fed once. The guinea pigs were starved thirty-six hours before the milk was offered them, and after it was placed in the cage no food or water was allowed until at least 40 c. c. had been consumed. When the guinea pigs were killed, about three months later, the postmortem examination showed that they were in excellent condition and free from lesions of disease.

From February 28, 1901, to July 27, 1901—a period of one hundred and forty-nine days—5 guinea pigs, Nos. 151 to 155, inclusive, were given room exposure to cow No. 4, and 5 guinea pigs, Nos. 156 to 160, inclusive, manger exposure to the same cow. A short time after the termination of the exposure, one manger-exposed guinea pig, No. 156, died, and on postmortem examination was found to be affected with generalized tuberculosis. The remaining guinea pigs, as well as 8

young guinea pigs, Nos. 161 to 168, inclusive, which were born in the room-exposure pen and were exposed from fifty to one hundred days, were killed some time later, and on postmortem examination were found to be in excellent condition and free from lesions of disease.

Hogs Nos. 7 and 8, young animals, weight about 40 pounds each, were fed daily about 500 c. c. of milk each from cow No. 4 from November 28, 1900, to May 22, 1901—a period of one hundred and seventy-five days. They were killed some time after the last day on which they were fed milk, and on postmortem examination were found to be in excellent condition and free from lesions of disease.

Cow No. 5 had been suffering with tuberculosis a long time and had a severe cough and was very thin and weak. She was killed on November 13, 1901, and on autopsy abundant tubercular lesions were found in the throat, mediastinal glands, and mesenteric glands, in the lung, liver, and spleen, and numerous tubercular excrescences on the costal and pulmonary pleura and the omentum. The lung contained several large tubercular abscesses in communication with bronchial tubes. No lesions of the udder or the lymph glands associated with it were found.

The record of cow No. 5, relative to guinea pigs injected and fed with milk obtained from her, and given room exposure and manger exposure in the stall she occupied (guinea pigs Nos. 169 to 257, inclusive), is in all respects identical with the record of cow No. 4, with the exception that no guinea pigs became affected with tuberculosis.

Cow No. 6 had been affected with tuberculosis for several years and was very thin and weak, and suffered with frequent severe paroxysms of cough. Died on August 12, 1904, after she had been down and unable to regain her feet, because of extreme weakness, for two or three days. The autopsy showed an advanced, extensive, generalized tuberculosis of the thoracic and abdominal organs. There were no visible lesions of the udder or the lymph glands associated with it.

From January 18, 1904, to February 8, 1904, 6 guinea pigs daily were injected intraabdominally with 6 c. c. each of milk from cow No. 6. The total number of guinea pigs injected was 132—Nos. 258 to 389, inclusive. The guinea pigs were killed about three to four months after the injections were made, and on postmortem examination were found to be in excellent condition and free from lesions of disease.

Hogs Nos. 9 and 10, in good condition; average weight, about 50 pounds. They were each fed daily from 500 to 700 c. c. of milk from cow No. 6 from June 1, 1901, to August 27, 1901—a period of eighty-seven days. The hogs were fed several years before the guinea-pig injections were made, and, as would be expected, when they were killed the postmortem examination showed that they were in excellent health and free from lesions of disease.

Hogs Nos. 11, 12, and 13 were in good condition; average weight, about 40 pounds. They were fed milk from cow No. 6 from October 15, 1901, to July 7, 1902—a period of two hundred and sixty-five days. The amount of milk eaten daily by each hog was from 500 to 700 c. c. The hogs were killed on January 27, 1903, and on postmortem examination were found to be in excellent condition and free from lesions of disease.

Cow No. 7 is still alive. She is very weak and thin and has been affected with tuberculosis for several years. During the last year her condition has been so poor that it is difficult to understand how she remains alive. No determinable lesions of the udder and the lymph glands associated with it are present.

Six guinea pigs—Nos. 390 to 395, inclusive—were fed milk of cow No. 7 from April 15, 1903, to December 22, 1903—a period of two hundred and fifty-one days. The amount of milk consumed daily by each guinea pig averages 70 c. c. The guinea pigs were killed some time after the last day on which they were fed milk, and on postmortem examination were found to be in excellent condition and free from lesions of disease.

Six guinea pigs—Nos. 396 to 401, inclusive—were fed milk of cow No. 7 from December 22, 1903, to December 14, 1904—a period of three hundred and fifty-seven days. The average amount of milk consumed by each guinea pig daily was 70 c. c. The guinea pigs were killed on December 21, 1904. One guinea pig, No. 396, was found on postmortem examination to be affected with generalized tuberculosis, and 5—Nos. 397 to 401, inclusive—were in excellent condition and free from lesions of disease.

Fifteen guinea pigs received each an intraabdominal injection of 5 c. c. of the milk of cow No. 7, as follows:

April 15, 1903, guinea pigs Nos. 402, 403, and 404.

July 14, 1904, guinea pigs Nos. 405, 406, 407, and 408.

July 22, 1904, guinea pigs Nos. 409, 410, 411, and 412.

August 12, 1904, guinea pigs Nos. 413, 414, 415, and 416.

The guinea pigs were killed from two to three months after the injections in each case were made and examined postmortem.

Guinea pigs Nos. 402 and 403, injected on April 15, 1903, were found to be affected with generalized tuberculosis. Guinea pig No. 404, injected on the same date, and guinea pigs Nos. 405 to 416, inclusive, injected on the later dates, were found to be in excellent condition and free from lesions of disease.

Cow No. 8 died on June 12, 1903, previous to which time she was so weak and thin that she could barely stand on her feet. The autopsy showed a generalized tuberculosis, but without lesions in the udder and the glands associated with it.

Three guinea pigs—Nos. 417, 418, and 419—received each an intra-

abdominal injection of 5 c. c. of the milk from cow No. 8 on April 15, 1903. Two of the guinea pigs, Nos. 417 and 418, died about two months later, and on postmortem examination were found to be affected with generalized tuberculosis. Guinea pig No. 419 was killed four months after the injection was made, and on postmortem examination was found to be in good condition and free from lesions of disease.

Five guinea pigs—Nos. 420 to 424, inclusive—were fed milk of cow No. 8 from April 15, 1903, to June 8, 1903—a period of fifty-five days. The average amount of milk consumed by each guinea pig daily was 70 c. c. When the guinea pigs were killed, some time after the last day on which they were fed milk, and examined postmortem, they were found to be in excellent condition and free from lesions of disease.

Cow No. 9 was killed March 14, 1902. Her general condition was excellent—fat. The autopsy showed a generalized tuberculosis of the thoracic and abdominal organs, with numerous and voluminous lesions. There was absolutely nothing in the condition of the cow during life to indicate the extensive character of the disease with which she was affected.

Four guinea pigs, Nos. 425 to 428, inclusive, were given room exposure to cow No. 9, and four others, Nos. 429 to 432, inclusive, manger exposure to the same cow, from January 2, 1902, to March 14, 1902—a period of seventy-one days. One young guinea pig, No. 433, was born in the manger pen and was exposed about sixty days.

The nine guinea pigs were killed on April 26, 1902. Guinea pig No. 425 (room exposure) was found on postmortem examination to be affected with generalized tuberculosis. Guinea pig No. 426 (room exposure) was found on postmortem examination to be affected with tuberculosis of the lung and liver. Guinea pigs Nos. 427 and 428 (room exposure) and guinea pigs Nos. 429 to 433, inclusive (manger exposure), on postmortem examination were found to be in good condition and free from lesions of disease.

Cow No. 10 was killed November 23, 1901. The autopsy showed a generalized tuberculosis of the thoracic and abdominal organs, with numerous and voluminous lesions. The throat glands were greatly enlarged and completely tubercular. No disease of the udder and the lymph glands associated with it was detected.

Two hogs, Nos. 14 and 15, in good condition, with an average weight of 40 pounds, were fed milk from cow No. 10 from August 27, 1901, to November 23, 1901—a period of eighty-eight days. The amount of milk eaten by each hog daily was 1,000 c. c.

The hogs were killed June 13, 1902, and on postmortem examination were found to be in excellent condition and free from lesions of disease.

Cow No. 11 was killed November 23, 1901. The autopsy showed extensive tubercular disease of the mediastinal glands and lung. The latter contained several large abscesses in communication with the bronchial tubes, and the bronchial tubes contained flakes of tubercular material, which was discharging from the abscesses. No other lesions were found.

Four hogs, Nos. 16 to 19, inclusive, were fed the milk from cow No. 11, as shown below. The hogs were in good condition at the time the feeding was begun and averaged about 40 pounds in weight. The daily quantity of milk eaten by each hog during the time it was fed was 1,000 c. c.

Hogs Nos. 16 and 17 were fed from October 23, 1900, to February 23, 1901—a period of one hundred and twenty-three days. The hogs were killed April 22, 1901, and on postmortem examination were found to be in excellent condition and free from lesions of disease.

Hog No. 18 was fed from August 24, 1901, to September 21, 1901—a period of twenty-eight days. It died on September 21, 1901, and on autopsy was found to be affected with hog cholera. No lesions of tuberculosis.

Hog No. 19 was fed from August 24, 1901, to November 23, 1901—a period of ninety-one days. Killed May 23, 1902, and on postmortem examination showed lesions of chronic hog cholera. No lesions of tuberculosis were present.

The results obtained from the various exposures made to the 11 tubercular cows used in the experiments are condensed in the following five tables:

TABLE 1.—Guinea pigs, lot A—Intraabdominal milk injections.

No. of cow.	No. of guinea pig.	Date of injection.	Amount of milk injected, each guinea pig.	Results.
			c. c.	
3	48-55	Feb. 12, 1901.....	6	No disease.
4	72-104	1 daily from Dec. 4, 1900, to Jan. 5, 1901, inclusive.	6	Do.
5	169-201	.....do.....	6	Do.
6	258-389	6 daily from Jan. 18 to Feb. 8, 1904.	6	Do.
7	402, 403, 404	Apr. 15, 1903.....	5	402 and 403, generalized tuberculosis; 404, no disease.
7	405-408	July 14, 1904.....	5	No disease.
7	409-412	July 22, 1904.....	5	Do.
7	413-416	Aug. 12, 1904.....	5	Do.
8	417, 418, 419	Apr. 15, 1903.....	5	417 and 418, generalized tuberculosis; 419, no disease.

The milk used for the intraabdominal injections of guinea pigs was obtained from 6 tubercular cows—Nos. 3 to 8, inclusive. Of these, Nos. 3, 6, and 8 died as the result of generalized tuberculosis; No. 4 was killed and found on autopsy to be only slightly affected; No. 5 was killed and found to be affected with generalized tuberculosis, and No. 7 is still alive, but undoubtedly affected with generalized tuberculosis. No observable disease of the udder was present in any case.

The number of guinea pigs that received injections was 224, and of these, 4, or 1.78 per cent, became tubercular. The total amount of milk injected into all the guinea pigs was 1,326 c. c., or about 3 pints.

TABLE 2.—Guinea pigs, lot B—Milk feeding.

No. of cow.	No. of guinea pig.	Date of feeding.	Number of days of feeding.	Amount of milk per day for each guinea pig.	Results.
				c. c.	
1	1-4	Aug. 24, 1901, to Dec. 27, 1901.	125	75	No disease.
1	5-8	Dec. 27, 1901, to Apr. 23, 1902.	117	100	Do.
2	22-25	Aug. 24, 1901, to Dec. 27, 1901.	125	75	Do.
2	26, 27, 28	Dec. 27, 1901, to Apr. 24, 1902.	118	75	Do.
3	50-59	Jan. 29, 1901, to Feb. 20, 1901.	22	50	Do.
3	60-63	Feb. 22, 1901, to May 12, 1901.	79	50	Do.
4	103-150	1 guinea pig daily, Dec. 4, 1900, to Jan. 18, 1901.	1	40	Do.
5	202-247	.....do.....	1	40	Do.
7	390-395	Apr. 15, 1903, to Dec. 22, 1903.	251	70	Do.
7	396-401	Dec. 22, 1903, to Dec. 14, 1904.	357	70	Guinea pig 396, generalized tuberculosis; guinea pigs 397 to 401, inclusive, no disease.
8	420-424	Apr. 15, 1903, to June 8, 1903.	55	70	No disease.

The milk fed to the guinea pigs was obtained from 7 cows, Nos. 1 to 5, inclusive, and Nos. 7 and 8. Of these, Nos. 3 and 8 died as the result of generalized tuberculosis; Nos. 1 and 5 were killed, and on autopsy found to be affected with generalized tuberculosis; No. 4 was killed and found to be only slightly affected, and Nos. 2 and 7 are still alive, but undoubtedly affected with generalized tuberculosis.

The number of the guinea pigs that were fed milk was 132, and of these only 1, or 0.76 per cent, became tubercular. The guinea pig which contracted tuberculosis was 1 of 6 which were fed daily for three hundred and fifty-seven days the milk of cow No. 7, which is still alive. The amount of milk fed was 446,490 c. c., or about 118 gallons. The average duration of the feeding was forty-seven and one-fifth days.

TABLE 3.—*Guinea pigs, lot C—Room exposure or wall-pen exposure.*

No. of cow.	No. of guinea pig.	Date of exposure.	Duration of exposure.	Results.
			<i>Days.</i>	
1	9	Aug. 28, 1901, to Nov. 12, 1901.	76	Pneumonia and inflammation of bowels.
1	10	Aug. 28, 1901, to Nov. 20, 1901.	84	Do.
1	11	Aug. 28, 1901, to Dec. 4, 1901.	98	Do.
1	12	Aug. 28, 1901, to July 9, 1902.	315	Do.
1	13	Aug. 28, 1901, to July 21, 1902.	327	No disease.
2	29-32	Dec. 27, 1901, to Sept. 17, 1902.	264	Do.
3	64-67	Feb. 26, 1901, to May 17, 1901.	80	Do.
4	151-155	Feb. 28, 1901, to July 27, 1901.	149	Do.
4	161-168	April to July, 1901	50-100	Do.
5	248-252	Feb. 28, 1901, to July 27, 1901.	149	Do.
9	425-428	Jan. 2, 1902, to Mar. 14, 1902.	71	No. 425, generalized tuberculosis; No. 426, tuberculosis of liver and lung; Nos. 427 and 428, no disease.

The room exposures or wall-pen exposures were made to 6 cows, Nos. 1 to 5, inclusive, and No. 9. Of these Nos. 1, 5, and 9 were killed, and on autopsy were found to be affected with generalized tuberculosis; No. 2 is still alive, but undoubtedly affected with generalized tuberculosis; No. 3 died as the result of generalized tuberculosis, and No. 4 was killed and found to be only slightly affected.

The number of guinea pigs that received room exposure was 35, and of these, 2, or 5.71 per cent, became tubercular. The average duration of the exposures was one hundred and thirty-five days.

TABLE 4.—*Guinea pigs, lot D—Manger exposure or manger-pen exposure.*

No. of cow.	No. of guinea pig.	Date of exposure.	Duration of exposure.	Results.
			<i>Days.</i>	
1	14	Aug. 28, 1901, to Jan. 31, 1902.	156	Pneumonia and inflammation of bowels.
1	15	Aug. 28, 1901, to Feb. 3, 1902.	159	Pneumonia.
1	16	Aug. 28, 1901, to Mar. 15, 1902.	189	Pneumonia and inflammation of bowels.
1	17, 18	Aug. 28, 1901, to July 31, 1902.	337	No disease.
1	19	Jan. 21, 1902, to July 21, 1902.	181	Do.
1	20	Feb. 12, 1902, to July 21, 1902.	159	Do.

TABLE 4.—Guinea pigs, lot D—Manger exposure or manger-pen exposure—Cont'd.

No. of cow.	No. of guinea pig.	Date of exposure.	Duration of exposure.	Results.
			<i>Days.</i>	
1	21	Mar. 5, 1902, to July 21, 1902.	138	Tuberculosis of liver, spleen, and mesenteric glands.
2	33	Oct. 27, 1901, to Jan. 13, 1902.	229	Pneumonia.
2	34	Oct. 27, 1901, to July 22, 1902.	268	Do.
2	35, 36	Oct. 27, 1901, to Sept. 12, 1902.	320	No disease.
2	37-47	December, 1901, to September, 1902.	60-200	No. 37, half-grown guinea pig, generalized tuberculosis; Nos. 38 and 39, full-grown guinea pigs, generalized tuberculosis; Nos. 40 and 41, pneumonia; Nos. 42 to 47, inclusive, no disease.
3	68-71	Feb. 26, 1901, to May 17, 1901.	80	No. 68, generalized tuberculosis; Nos. 69 to 71, inclusive, no disease.
4	156-160	Feb. 28, 1901, to July 27, 1901.	149	No. 156, generalized tuberculosis; Nos. 157 to 160, inclusive, no disease.
5	253-257	.....do.....	149	No disease.
9	429-432	Jan. 2, 1902, to Mar. 14, 1902.	71	Do.
9	433	January to March, 1902.	60	Do.

Guinea pigs lot D were exposed to the same cows to which guinea pigs lot C, Table 3, were exposed. The total number of guinea pigs that received manger exposure was 42, and of these 6, or 14.28 per cent, became tubercular. The average duration of exposure was one hundred and fifty-one and one-half days.

TABLE 5.—Milk feeding of hogs.

No. of cow.	No. of hog.	Date of feeding.	Duration of feeding.	Amount of milk per day.	Results.
			<i>Days.</i>	<i>c. c.</i>	
1	1	Aug. 27, 1901, to Nov. 23, 1901	88	500	No disease.
2	2, 3	June 1, 1901, to Oct. 4, 1901	125	300-500	Do.
3	4, 5, 6	Aug. 9, 1900, to Jan. 28, 1901	172	500-700	Do.
4	7, 8	Nov. 28, 1900, to May 22, 1901	175	500	Do.
6	9, 10	June 1, 1901, to Aug. 27, 1901	87	500-700	Do.
6	11, 12, 13	Oct. 15, 1901, to July 7, 1902	265	500-700	Do.
10	14, 15	Aug. 27, 1901, to Nov. 23, 1901	88	1,000	Do.
11	16, 17	Oct. 23, 1900, to Feb. 23, 1901	123	1,000	Do.
11	18	Aug. 24, 1901, to Sept. 21, 1901	28	1,000	Hog cholera.
11	19	Aug. 24, 1901, to Nov. 23, 1901	91	1,000	Chronic hog cholera.

The hogs were fed milk obtained from 7 tubercular cows, Nos. 1 to 4, inclusive, and Nos. 6, 10, and 11. Of these, Nos. 1 and 10 were killed and found to be affected with generalized tuberculosis; No. 2 is alive, but undoubtedly affected with generalized tuberculosis;

Nos. 3 and 6 died, and on autopsy the cause of death was found to be generalized tuberculosis; and Nos. 4 and 11 were killed and the former found on autopsy to have only slight and the latter severe tuberculosis of the lung.

The number of hogs that were fed milk was 19, and of these not one became tubercular. The total amount of milk fed was 1,751,000 c. c., or about 462½ gallons. The average duration of the feeding was one hundred and forty-three days.

The positive results obtained from the several exposures compare as follows:

	Per cent.
Milk injection, guinea pigs-----	1.78
Milk feeding, guinea pigs-----	.76
Room exposure, guinea pigs-----	5.71
Manger exposure, guinea pigs-----	14.28
Milk feeding, hogs-----	0.00

The percentages given do not correctly illustrate the delicacy of intraabdominal injections of guinea pigs as a test for the presence of tubercle bacilli. It is better shown by more careful study of the guinea pigs used in the milk-injection and milk-feeding experiments.

The 224 injected guinea pigs received altogether only 1,326 c. c. of milk, while the 132 fed guinea pigs received a total of 446,490 c. c. of milk; that is, the latter received 336 times as much milk as the former guinea pigs. An even more emphatic illustration of the delicacy of the injection test is given in the results with the milk of cows Nos. 7 and 8, the only cows in the experiments the milk of which produced positive results. Injections were made with the milk of the 2 cows at the same time that the milk was being fed, and the numbers of guinea pigs that were injected and fed were almost equal. The total amount of milk injected into 18 guinea pigs from cows Nos. 7 and 8 was 90 c. c., and this produced 4 cases of tuberculosis—2 with the milk from each cow. The total amount of milk from cows Nos. 7 and 8 fed to 17 guinea pigs was 274,610 c. c., and this produced only 1 case of tuberculosis. The positive case was one of 6 guinea pigs fed the milk of the less severely affected cow for three hundred and fifty-seven consecutive days, during which time the guinea pigs each consumed an average of 70 c. c. of milk daily. The milk that was injected was in proportion to the milk that was fed as 1 to 3,051½, and the positive results were 4 from injections and 1 from feeding. If we assume that the occurrence of tubercle bacilli was fairly constant in the milk of the 2 cows, the mathematical value of the injection test in this particular experiment is shown to be over 12,000 times as great as the value of the ingestion test.

This matter has been gone into at some length because it demon-

strates that the danger of infection with tuberculosis through the use of milk, while very important in itself, is very slight as compared with other sources of infection, and because this lesser danger is extremely significant in connection with several recently developed facts concerning tuberculosis in man.

We know to-day, by all the tests we can legitimately apply, that tubercle bacilli isolated from lesions in cattle are more virulent than bacilli isolated from lesions in man, and that the majority of tubercle bacilli found in human lesions, which are sufficiently virulent to infect cattle, are obtained from children. Some of the followers of Dr. Robert Koch assert, in their insistence that human and bovine tuberculosis are different diseases, that tubercle bacilli isolated from man that possess sufficient virulence to infect cattle are bovine bacilli, with which man has somehow, in some surprising manner, become infected. And this conclusion they strengthen by pointing out peculiarities in the morphology of the bacilli which failed to select their proper host.

We know that the only real source of infection with tuberculosis through cattle, to which children are ordinarily exposed, is the milk they drink. Hence, if guinea pigs, which have always been regarded as highly susceptible to tuberculosis, can daily, for long periods of time, drink large quantities of milk from cows known to be affected with generalized tuberculosis, and in some cases milk in which the presence of tubercle bacilli has been demonstrated by the intra-abdominal injection of other guinea pigs, without becoming infected with tuberculosis; and the greater frequency in the lesions of tubercular children of bacilli of sufficient virulence to infect cattle counts for anything, no possible feeling of uncertainty can remain to weaken the conclusion that children, at any rate, are very susceptible to cattle tuberculosis.

In this connection a reference made in a recent number of the British Medical Journal and in other publications to the latest recorded observations of the German Committee for the Investigation of Tuberculosis, which came into existence after the declaration of Doctor Koch for the distinctive grouping of human and bovine tubercle bacilli, is of great interest. We are told that 56 different tubercle bacilli were isolated from human lesions, and that 6 of them, or 10.71 per cent, were found to be bovine tubercle bacilli. The human bacilli are distinguished from the bovine by morphological characteristics. We are also told that tubercle bacilli are constant in their varietal character, hence human bacilli are always human bacilli and bovine bacilli likewise always bovine bacilli. There may be much light thrown on these statements through an examination of the investigations in detail on which they are supported, but in their present form they constitute an amazing series of declarations, which, if

taken seriously, point to a number of highly interesting and equally important conclusions.

It has already been stated that the greatest danger of infection with tuberculosis through cattle to which man is exposed is milk; to this should be added butter and possibly cheese and the exposure of men whose occupations place them in frequent contact with cattle. Meat, which is rarely eaten in a raw state, and usually, if at all infected, is so infected through the germs which have reached its outer surface (the part most exposed to the sterilizing effects of the heat applied in cooking) through contact with a soiled knife or hand or other infected material need hardly be referred to. The exposure of man to human tubercular infection is infinitely greater, and this fact is generally admitted. The bacilli encounter him everywhere—on the streets, in public rooms, in public conveyances, on articles of food handled by affected persons and not afterwards sterilized by the application of heat, carried into his house on his own clothing and especially on the long skirts of women, in the books obtained from libraries, and, in one of the worst forms, in the atmosphere while conversing with tubercular-affected persons, etc. And yet, a responsible investigating committee, composed of men presumably selected with a careful regard for their ability to deal with the subject, announces that over 10 per cent of the tubercle bacilli isolated by them from human lesions in a series of special investigations are bovine tubercle bacilli, and that bovine tubercle bacilli are morphologically constant organisms. It almost justifies the assumption, when we bear in mind that human bacilli are rarely virulent for cattle and a number of other animals and that bovine bacilli are infectious for a great variety of animals—the *Quadrumana*, the closest possible biological approach to man, included—that tuberculosis of man would be a much simpler problem to deal with if the constantly occurring accretions of superlatively virulent bacilli through the milk pail could be effectually stopped. At least no stronger or more valid reason could be given to make persistent and untiring efforts to remove every trace of tuberculosis from our dairy herds. The numerous new facts which have been established through the increased activity given the investigation of tuberculosis by Doctor Koch's famous London utterances all tend to support this conclusion.

The several cows used in the experiments merit a more detailed separate discussion, because it seems to us that a number of valuable conclusions can be drawn from them.

The tuberculosis with which cow No. 1 was affected was sufficiently advanced and of a kind at the time the exposures were made to her for a dairyman or person experienced in the common care of cattle to make a diagnosis. Among the 8 guinea pigs and 1 hog that were

fed milk and the 5 room-exposed and 8 manger-exposed guinea pigs, only 1, a manger exposure, became affected with tuberculosis. The percentage of positive results, 4.55, is unexpectedly small from exposure to a cow so severely affected, but amply large to demonstrate the dangerous character of her disease.

Little can be added to the record of cow No. 2. The disease with which she is affected is evidently of the kind which progresses very slowly. She was known to be tubercular as early as the year 1900, and is now (January, 1905) alive, and her condition gives every promise that she will last a year or possibly two years longer. Among the 7 guinea pigs and 2 hogs that were fed milk and the 4 room-exposed and 15 manger-exposed guinea pigs, 3, or 10.71 per cent, contracted tuberculosis. The 3 guinea pigs which became affected belonged to the 11 animals born in the manger pen and constitute $27\frac{1}{4}$ per cent of these young animals. This result speaks strongly for the conclusion that young animals are more susceptible to tuberculosis than older animals.

It is a fact worthy of note that the exposure of the guinea pigs which contracted tuberculosis from cow No. 2 ended September 12, 1902, or about two and one-fourth years ago, and hence that the cow was spreading tubercle bacilli at that time and probably has been doing so ever since, and will continue to do so until she is dead. It can not be supposed that she has improved in this respect. Tuberculosis is a progressive disease and not a self-limited affection; hence it is fair to assume that an animal from which tubercle bacilli were being eliminated at any time may be an animal from which an equal or greater number of tubercle bacilli are probably being eliminated at any subsequent time. The cow is emphatically one of the cases of tuberculosis, of which there are doubtless many in dairy herds, that help to keep up the supply of infectious material. The practical conclusion to be drawn from her is the absolute necessity of the separation of all tubercular cattle from contact with other animals the moment the existence of tubercular disease is discovered through the use of tuberculin or by other methods.

The condition of cow No. 3, in consequence of the tubercular disease with which she was affected, was such that she should have been retained in no dairy herd. Among the 8 guinea pigs that received intraabdominal injections of milk, the 8 that were fed milk, and the 4 guinea pigs that received room exposure, and the 4 that received manger exposure, and the 3 hogs that were fed milk, only 1 animal, a manger-exposed guinea pig, contracted tuberculosis—1 out of a total of 27, or 3.7 per cent. As in the case of cow No. 1, the number of positive results from the exposures is surprisingly small.

The amount of tuberculosis found in cow No. 4 on postmortem examination was very small, and of a kind which was in no visible

communication with the exterior of the animal; but that she was spreading tubercle bacilli is shown to be a fact by the development of tuberculosis in one of the guinea pigs exposed to her. She was in excellent condition—so fat that she would have made a good beef animal. She was young, and showed absolutely no symptoms from which tuberculosis could be diagnosed without the aid of tuberculin. If a tuberculin test had not led to her separation from the dairy herd to which she originally belonged, it is very probable that she would have remained alive and an active agent for the infection of other cattle during a year or two or possibly for even a longer time.

Cow No. 4 shows even more emphatically than cow No. 2 how absolutely necessary it is for the eradication of tuberculosis from a herd of cattle to remove every animal to which the least suspicion of tuberculosis attaches.

In anticipation of the claims that the guinea pigs exposed to the several cows in this series of experiments do not constitute a fair test of the dangerous character of tubercular cows for other cattle, because of the generally believed high susceptibility of guinea pigs to tuberculosis, attention is called to an experiment published in the Twentieth Annual Report of the Bureau of Animal Industry. In the experiment referred to, 7 healthy cattle were exposed to 3 tubercular cows, and at the same time 100 guinea pigs received room exposure and manger exposure to the same tubercular cows. At the end of the exposure the cattle and guinea pigs were killed and examined post-mortem. The examination showed that 6 of the 7 cattle, or 85.71 per cent, had become tubercular, and that only 1 of the guinea pigs, or 1 per cent, had become infected. It is quite possible that the number of strictly virulent tubercle bacilli which must enter the body of a cow to cause a progressive tubercular disease is no larger than the number required to infect a guinea pig. If this is true, the results obtained in the experiment in which the cattle and guinea pigs were simultaneously exposed are precisely in accordance with what should have been expected, because the cattle breathed a much larger volume of dust-laden and tubercle-infected air and consumed a much larger mass of possibly soiled and infected forage than the guinea pigs. Hence, also, the fact that 1 of the guinea pigs which received room exposure and manger exposure to cow No. 4 became tubercular must be regarded as indicating that the cow was an exceptionally dangerous animal, notwithstanding the comparatively slight lesions found on autopsy.

The amount of tuberculosis found in cow No. 5, on the other hand, was enormous, and abscesses existed in the lung and were in direct communication with the bronchial tubes. The absence of disease among the guinea pigs exposed to her is more surprising than the

infection of every one of them would have been. The cow, when compared with cows Nos. 2 and 4, justifies the important conclusion that visible and more extensively tubercular cattle are by no means always the greater menace to other animals exposed to them. Animals like cow No. 5—thin, weak, coughing, and displaying a whole group of symptoms characteristic of distress and advanced disease—also have the advantage, in matters related to the restriction of disease among man and animals, that their very condition is a warning against contact and intimate association. Such animals are instinctively avoided, because we all know that disease carries with it many unknown possibilities of transference, in addition to those that are recognized, from the already affected to the still unaffected. Cow No. 5 is clearly the danger we recognize and avoid, and cow No. 4 is equally the danger, of no less magnitude, which borrows an unpleasant additional potency from its concealed nature, and is for that reason one of the strongest arguments that can be presented for the application of the tuberculin test to all cattle and for the immediate slaughter of all cattle that react.

It is remarkable that not one of the 132 guinea pigs injected (6 daily for a period of twenty-two days) with milk from cow No. 6 became affected with tuberculosis. The cow had been tubercular several years at the time the guinea-pig injections were made, and died six months later as the result of generalized tuberculosis. In connection with this cow it should be borne in mind that the milk used for feeding and injection exposures was taken from the various cows used, with the greatest precautions to prevent its infection with bacilli present in the air or dust in the stable, with infected bedding or particles of forage, or with bacilli adherent to the hair and skin of the cows or on the hands of the persons who milked the cows. It does not seem quite reasonable to suppose that tubercle bacilli should occur commonly in the milk of tubercular cows with unaffected udders unless they reach it in some way not directly associated with the normal milk-secreting functions. While we have no satisfactory evidence to offer for or against the passage of tubercle germs from the bodies of tubercular animals through unaffected normal secreting organs, it is our impression that bacteria which, like tubercle bacilli, localize themselves in the body and rarely float in the blood are seldom eliminated through any kind of healthy organs, the udder included.

If this view is as true as it seems reasonable, we must attribute the frequently present tubercular infection in the milk of cows to other causes than its passage from the animal through the udder. Such causes would be the infection of the milk in one of the ways we tried to avoid by the special precautions previously specified or by some

other similar means. And this points to another danger through the use of milk, because, in a stable containing both healthy and diseased animals, the milk from the healthy is probably just as unwholesome and dangerous as the milk from the diseased, and this is an additional argument for the general application of the tuberculin test to cattle and the immediate slaughter of all reacting animals.

Cow No. 7, affected with advanced tuberculosis, is still alive. The milk drawn from her on April 15, 1903, produced tuberculosis in 2 of 3 guinea pigs injected with it. Milk drawn from the same cow more than a year later, on three different days—July 14, July 22, and August 12, 1904—and injected, respectively, into three lots of 4 guinea pigs each, failed to produce disease. The absence of disease in 1 of the first 3 guinea pigs injected seems to signify that either the distribution of the tubercle bacilli in the milk was not at all uniform or that the number of bacilli present was very small. The absence of disease in the 12 guinea pigs injected in 1904, at a time when the symptoms of tuberculosis in the cow were very much more marked, almost justifies the conclusion that the milk injected on the earlier date became infected with tubercle bacilli in some other way than through the milk-secreting structures of the cow—that is, notwithstanding the precautions taken to prevent the occurrence with bacilli which reached the milk from the exterior of the cow, either from her hair or skin, or by the accidental entrance of some small infected particles of material discharged by the animal at the time she was being milked, from her nose or mouth, directly into the pail or on the hands of the person who milked on the day in question. The latter is fairly probable, because it was the milk from cow No. 8, of April 15, 1903, the same day, which produced the only two other positive results obtained with intraabdominal injections of milk from cows with unaffected udders.

The 5 guinea pigs that were fed daily with milk from cow No. 8 during fifty-five consecutive days remained unaffected, and among the 12 guinea pigs that were fed milk from cow No. 7—6 for a period of two hundred and fifty-one days and 6 for a period of three hundred and fifty-seven days—only 1 contracted tuberculosis, and that one was among the 6 which daily consumed 70 c. c. of milk each for a period of three hundred and fifty-seven days. The time is certainly of sufficient length to justify the assumption that even the greatest precautions, most carefully practiced, failed in one instance to prevent the entrance into the milk of infectious material from the exterior of the animal, possibly in the form of a particle of forage or a mass of mucous which infected the guinea pig that happened to swallow it. The other alternative is to suppose that tubercle bacilli occur periodically in the milk of tubercular cows with apparently

healthy udders in numbers insufficient to affect guinea pigs on ingestion unless they are unusually susceptible to tuberculosis. We feel confident, however, that no disease would have occurred among the milk-fed guinea pigs if every source of milk infection from the exterior could have been effectually eliminated, and that probably all the guinea pigs that were fed milk for very long periods of time would have become affected with tuberculosis if the tubercular cows had been milked with no greater precautions to prevent infection of the milk from without than is practiced, or can be conveniently and economically practiced, in the great majority of dairy stables. And here, again, we have an argument for the complete removal of all tubercular cows from dairy herds.

It is a matter of indifference to the sufferer whether the cause of his affliction reached him through the secretory structures of a food-producing animal or through the contamination of food because of its exposure to an unclean environment. The view we express of the possible infection of the milk of cows Nos. 7 and 8 with tubercle bacilli from other sources than the apparently normal secreting structures of the udder is only conjectural, and it is gone into at some length mainly to accentuate our conviction that the infection of milk with tubercle bacilli through other sources than unaffected udders of tubercular cows is the much greater danger.

Cow No. 9 is an excellent illustration of a frequently observed fact, namely, the absence of visible symptoms of disease in the presence of advanced tuberculosis with extensive and voluminous lesions. We have a number of records at the experiment station of sleek, fat cattle, apparently in the best health at the time they were killed, which were found to be extensively tubercular on postmortem examination. One case was especially impressive and merits a reference to it here. It is the record of the best conditioned and fattest cow in a dairy herd of over 20 animals, a number of which were slaughtered after they had reacted to tuberculin. The cow was in prime beef condition; she had not shown a symptom of sickness within the memory of the persons interested in her; she reacted typically to the tuberculin test; her semblance of perfect health caused the expression of much doubt regarding the significance of the reaction, and on autopsy she was found to be the most extensively diseased animal among the nine or ten tubercular cows removed from the herd, some of which were very badly affected.

Cattle of this kind, a group to which No. 9 belongs, show that it is impossible to clean dairy herds of tubercular animals without the use of tuberculin. That animals like No. 9 are dangerous is shown positively by the fact that 2 of the 4 guinea pigs which received room exposure in her stall became affected with tuberculosis—that is to say,

this cow, fat, in excellent condition, and apparently in perfect health, was evidently more active in scattering tubercle bacilli than some of the other tubercular cows used in our experiments, notwithstanding that the latter were emaciated, weak, affected with a cough, and displayed many other evidences of disease.

Cows Nos. 10 and 11 require no special discussion. They were animals affected with generalized tuberculosis without lesions of the udder or structures adjacent to it. The several hogs that were fed milk obtained from the 2 cows did not become tubercular. The milk was drawn with considerable precautions, such as can not be practiced economically in dairy herds, to prevent its infection with tubercle bacilli from the exterior of the cows or their environment.

The tendency of the results obtained from our experiments is to point to the conclusion that the presence of tubercular cows in a dairy herd is a danger which affects not only the health of the persons who use the milk, but also the prosperity of the owner of the cattle, and consequently that it is necessary, both for moral and economical reasons, that our dairy herds should be made free from tubercular animals as soon as possible. No man can conscientiously sell infected milk when he has become acquainted with the harm it may do, and no man will voluntarily continue to expose his property to a danger the importance of which he has learned to know.

Too much stress can not be laid on the fact that tubercle bacilli are apparently more numerous in the environment of tubercular cattle than in their secretions from organs, like the udder, which have not become involved in the disease. Irrespective of the view that may be taken relative to the elimination of tubercle bacilli from the bodies of tubercular animals in their secretions from unaffected organs, it must be admitted that the chance for the introduction into these secretions, or into the secretions of healthy animals in the same environment, of infected material, such as particles of soiled forage or bedding, dust, masses of mucus which have adhered to the skin and hair, etc., is a very great danger, decidedly of too much importance to be ignored. The habit which cattle have of licking each other is sufficient to account for the occurrence of tubercle bacilli in the milk of a healthy cow into which some of her hair or scales of epidermis have fallen after she has been in contact with a cow affected with tuberculosis of the respiratory organs.

With these facts in mind and the knowledge that tuberculin is an almost unfailing agent for the diagnosis of tuberculosis, and that cattle are generally resistant to the form of infection to which they may be exposed through contact with tubercular human beings, very little excuse remains for the much longer existence of tuberculosis among either dairy cows or other cattle.